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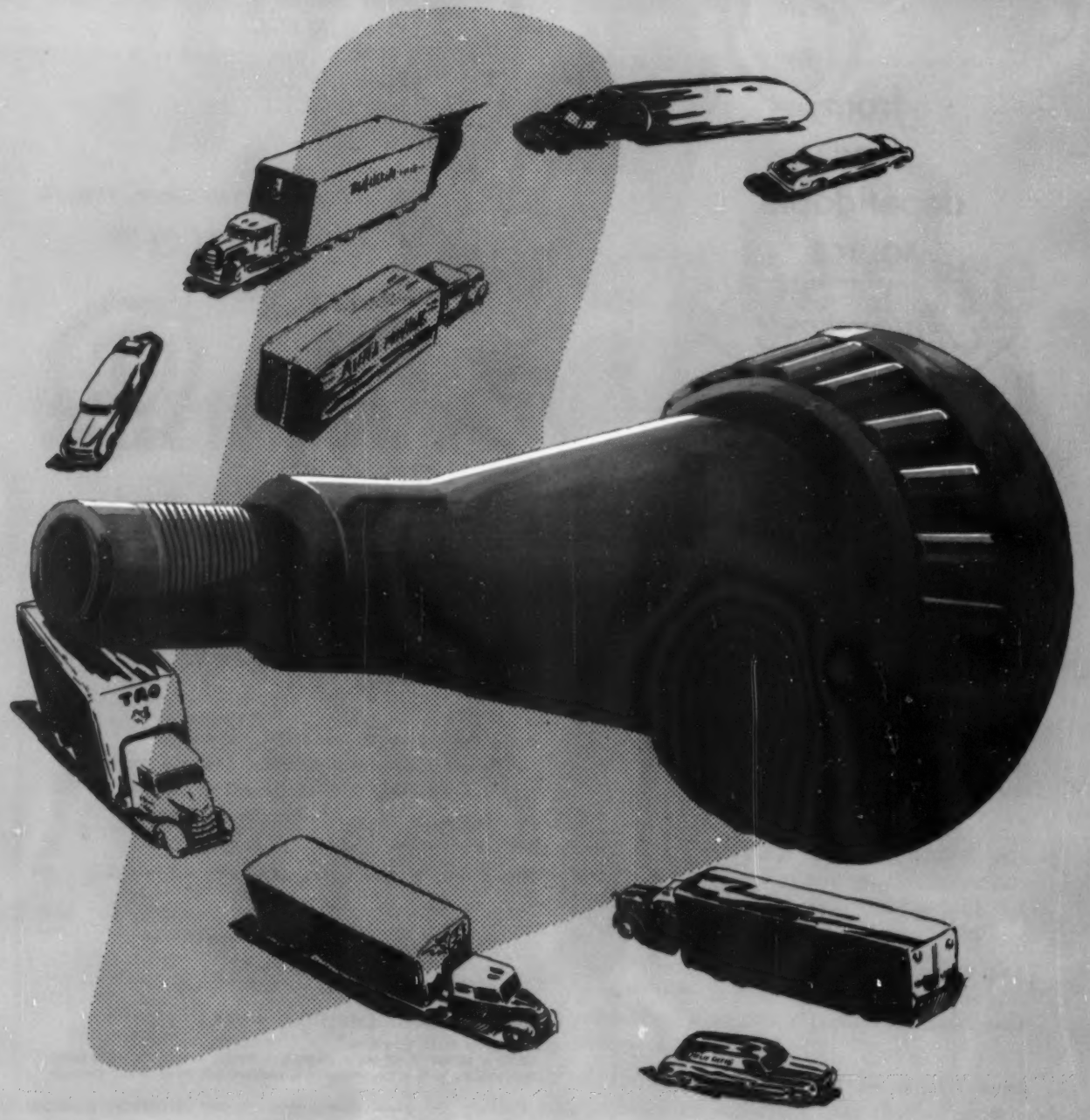
Journal of National Lubricating Grease Institute



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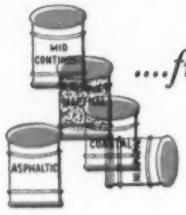

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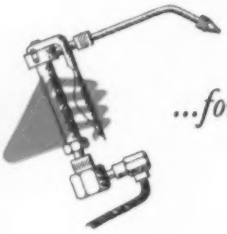

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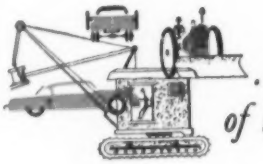

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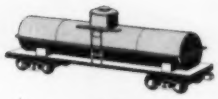
Whether you buy your lubes { **by the**  **by the**  **or by the** 

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President's page

by G. A. OLSEN, President, N L G I

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Did you ever see your dream walking in San Francisco? Just picture the smile of satisfaction that you and your wife will be wearing when you attend the Institute Session in San Francisco next October.

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IN THIS ISSUE

ABOUT THE COVER

In this issue you will read an article, "Evaluation of Wheel Bearing Grease Performance," which gives the results of extensive field tests. After looking over an excellent variety of illustrations given us by authors, Forster and Kolfenbach, our artist came up with a wheel bearing. This seemed to call for other circular motion so he surrounded the main illustration with trucks and cars circulating around it.

It seemed to illustrate the article, so we put it on the cover.

Evaluation of Wheel Bearing Grease Performance

E. O. Forster
J. J. Kolfenbach

Esso Laboratories

Introduction

The production of high quality lubricants for automotive wheel bearings is an increasingly important responsibility of the grease industry. The number of vehicles and the total mileage driven are increasing yearly. The Bureau of Public Roads estimates that the registration of motor vehicles will reach about 54,700,000 by the end of 1953. This represents a gain of 10,000,000 vehicles during the last four years. It is estimated that 15 to 17 million wheel bearing grease jobs will be performed this year.

Together with the increase in the size of the market, the service conditions under which the lubricants perform have become more severe. Over the years the design of wheel bearings has not been changed, although the driving speed has increased. The trend toward longer intervals between servicing the wheel bearings also requires a longer service life of the lubricant. Truck and fleet operators desire a grease that would require attention only at times when the brakes have to be relined. Grease manufacturers must keep abreast of these demands with products that will satisfy the lubrication requirements of cars and trucks alike, and avoid as much as possible the complaints of lubricant leakage and premature bearing failure.

To do this, the industry needs means of evaluating their newly developed products. This paper discusses ways of evaluating wheel bearing greases. The value of various presently accepted standard laboratory tests is criti-

Shown in the picture at the left are the authors of this article rating the wheel bearings of one of the test trucks.

cally viewed as to their significance in predicting bearing performance. Three types of field tests are described that permit the thorough evaluation of the test greases in a large variety of applications, thus correctly predicting their actual performance. Factors other than grease quality which cause wheel bearing failure are also discussed.

Presentation of Data and Discussion

Four wheel bearing greases were selected for evaluation. Conventional laboratory tests and extensive field tests covering about 1,250,000 miles were carried out on the four products.

A. Laboratory Evaluation

A wheel bearing grease must retain its structure at temperatures ranging from ambient to 200°F., with occasional top temperatures up to 250°F. It also must be of sufficient consistency to avoid slumping in the various parts of the bearing assembly, which might lead to leakage. Furthermore, it should be able to withstand the combined effects of both temperature and shearing action encountered in the bearing. The commonly accepted laboratory tests to measure these properties are summarized below:

1. ASTM Dropping Point Method D566-42. A minimum value of 300°F. is generally required.
2. ASTM Cone Penetration Method D217-48. A worked penetration ranging from 265 to 295 mm./10 is generally specified.
3. Wheel Bearing Test (a tentative ASTM method). Satisfactory passage in this test permits up to 10 gram leakage from a modified front wheel hub and spindle assembly in the course of a 6-hour test run at 220°F. spindle temperature and 440 RPM (the latest version of this test prescribes a speed of 660 RPM).

The extent to which these requirements have been accepted as guiding standards is reflected in the fact that they have been incorporated in the military specification for wheel bearing greases, MIL-G-2108.

All four greases were submitted to these three tests and fulfilled the requirements satisfactorily. Their physical properties and soap types are summarized in the following table.

Physical Properties of Test Greases

Properties	*Grease A*	*Grease B*	*Grease C*	*Grease D*
Soap Type	Sodium	Lithium/ Calcium	Complex Sodium	Sodium
ASTM Drop. Point, °F.	393	345	463	328
ASTM Penetration at 77°F., in mm./10				
Unworked	270	280	268	252
Worked 60 Strokes	289	286	272	265
Wheel Bearing Test (6 Hrs. at 220°F. and 440 RPM)	Pass	Pass	Pass	Pass

B. Field Evaluation

Field testing was carried out to determine the adequacy of these products under the various conditions encountered in actual service. The field tests were designed to evaluate such variables as leakage, wear, and overall bearing lubrication under a wide variety of driving conditions. The influences of the individual driver and of possible variations caused by different driving habits were eliminated by lubricating the left and right front wheel of each vehicle with a different grease. The recommended arrangement for evaluating four greases is shown in the table below.

Typical Distribution of Four Test Greases in a Field Test

Vehicle No.	*Left Wheel*	*Right Wheel*	*Vehicle No.*	*Left Wheel*	*Right Wheel*
1	A	B	7	C	A
2	A	C	8	C	B
3	A	D	9	C	D
4	B	A	10	D	A
5	B	C	11	D	B
6	B	D	12	D	C

This arrangement gives all possible combinations for four greases. To achieve all combinations, at least 12 vehicles are needed. Additional units can be included for further control and to compensate for possible loss of test vehicles due to extraneous circumstances. For testing only three greases, six units would be the minimum

Figure 1A—Outer Bearing of Passenger Car Front Wheel After 10,000 Miles.

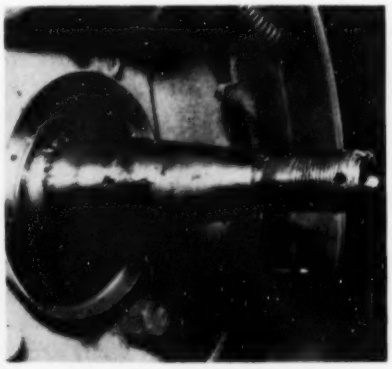

Figure 1B—Spindle of Passenger Car Front Wheel After 10,000 Miles.

Figure 1C—Inner Bearing and Seal of Passenger Car Front Wheel After 10,000 Miles.

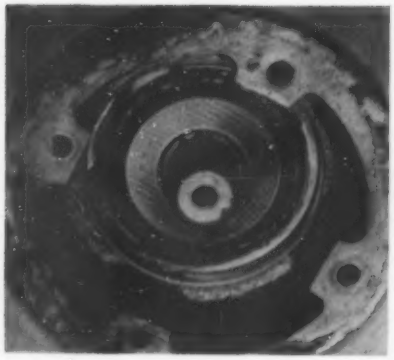

Figure 2A—Outer Bearing of Heavy Duty Truck Front Wheel After 40,000 Miles Using Grease A, B, or C.

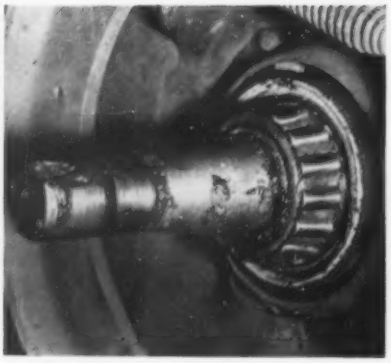

Figure 2B—Spindle and Inner Bearing of Heavy Duty Truck Front Wheel After 40,000 Miles Using Grease A, B, or C.

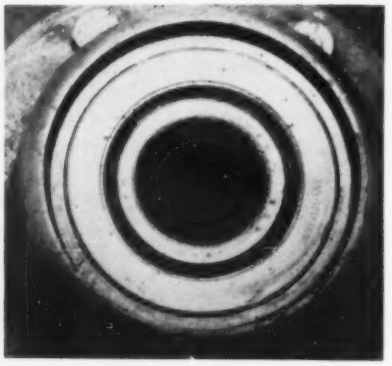

Figure 2C—Inner Bearing and Seal of Heavy Duty Truck Front Wheel After 40,000 Miles Using Grease A, B, or C.

required. Such an arrangement avoids erroneous ratings caused by possible variations in test severity. For instance, it is commonly believed that the left wheel of a unit is exposed to more severe moisture conditions than the right wheel due to additional splashes of water produced from oncoming traffic. Since at least three right wheels were tested simultaneously with three different left wheels, such factors would show up consistently and would be accounted for in the rating of the respective test greases.

Three field tests were run to cover the range of conditions likely to be encountered in actual service. In two tests, passenger cars were used to evaluate three greases (A, B, and C). In the third test, heavy duty trucks were used to evaluate all four greases. The first group of nine passenger cars was driven at high speed in hot, dusty regions covering from 31,000 to 35,000 miles and accumulating an average of about 30,000 miles a year. The second group of 12 cars was driven under average urban and suburban conditions covering from 7,500 to 12,500 miles and averaging about 10,000 miles per year. The group of 14 heavy duty trucks followed a routine representative of average intrastate delivery service covering from 2,000 to 55,000 miles and averaging about 20,000 miles per year. The detailed conditions of these field tests are shown in the table below.

Wheel Bearing Grease Field Test Conditions

	Passenger Cars		*Heavy Duty*
Conditions	*High Speed*	*Normal*	*Trucks*
Maximum Speed, MPH	50-60	30-40	35-50
Ambient Temperature, °F.	60-90	30-80	30-80
Road Conditions	Dusty	Paved	Paved
Types of Bearings	Ball	Ball and Roller	Roller
Miles Covered/Year (Avg.)	30,000	10,000	20,000

The procedure followed in lubricating the wheel bearings was as follows:

New bearings with the appropriate races and seals were installed at the beginning of the field tests. Each bearing was thoroughly inspected before installation and cleaned with solvent and subsequently dried in a blast of clean dry air. The bearings were packed by hand or mechanical packer avoiding overpacking by removing excess grease by hand. A thin film was applied to the races and the hub packed with grease so that the grease was flush with the races. After a wheel was mounted, care was taken to seat and align the bearings properly by applying a 60 inch-pound torque when tightening the assembly. This was followed by a backing off from 30° to 60° depending on the construction of the fastening mechanism. No grease was put in the hub cap.

The total mileage covered with each grease in the three tests is summarized in the table below.

All units were inspected after six months by pulling the wheel without disturbing the grease on the bearing or in the hub. At the end of the tests, after about a year, the units were taken off test and the bearing assemblies inspected and rated.

C. Results

Based on leakage characteristics and general appearance of the greases and the bearings at the end of the field tests in both passenger car and heavy duty truck service, Greases A, B, and C were rated as excellent. Grease D was rated poor on the basis of its performance in heavy duty trucks.

Wheel bearings lubricated with either Grease A, B,

Number of Vehicles and Total Mileage Covered with Test Greases

	High Speed Test		*Normal Test*		*Heavy Duty Test*		*Total*	
Grease	*No. of Cars**	*Mileage*	*No. of Cars**	*Mileage*	*No. of Trucks**	*Mileage*	*No. of Vehicles**	*Mileage*
A	6	203,217	11	108,592	7	189,461	24	501,270
B	6	196,058	6	59,937	9	162,960	21	418,955
C	6	194,015	6	60,800	6	111,447	18	366,262
D	.	..	..	..	6	78,083	6	78,083

*Only one of the two spindles of the vehicle was lubricated with the respective grease.

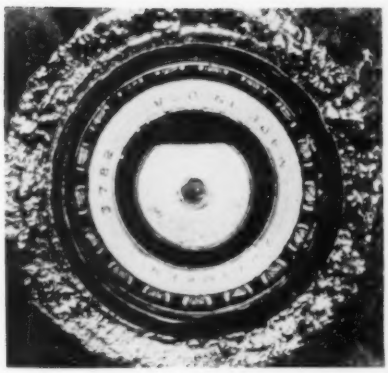

Figure 3A—Outer Bearing of Heavy Duty Truck Front Wheel After 20,000 Miles Using Grease D.

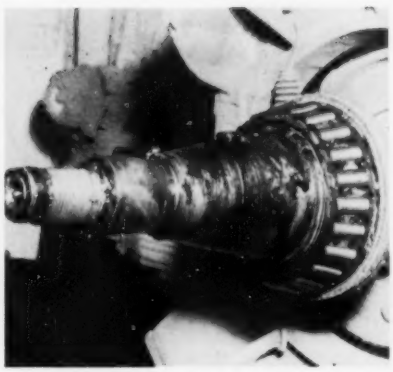

Figure 3B—Spindle and Inner Bearing of Heavy Duty Truck Front Wheel After 20,000 Miles Using Grease D.

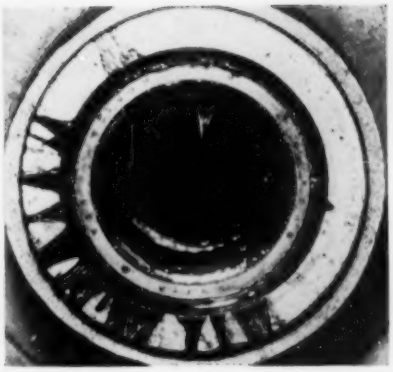

Figure 3C—Inner Bearing and Seal of Heavy Duty Truck Front Wheel After 20,000 Miles Using Grease D.

or C did not show any measurable leakage of grease or oil. The appearance of the bearings in these units was very satisfactory with no visual indication of wear. The three greases were found to remain unchanged in the hub of both passenger and heavy duty vehicles. A representative passenger car front wheel bearing assembly after 10,000 miles of service is shown in Figures 1a, 1b, and 1c. There was no observable difference in the performance of these greases in either ball or roller bearings. Figures 2a, 2b, and 2c show a spindle and inner bearing of a heavy duty truck after 40,000 miles of service using Grease A. The same picture prevailed for Greases B and C. The satisfactory performance and appearance of Greases A, B, and C in tests run to 30,000 miles in passenger cars and to as much as 55,000 miles in heavy duty trucks suggest that these greases provide a very wide safety margin when the most generally recommended 10,000 mile relubrication period is followed.

Grease D was rated poor because of leakage, varnish formation and gelling tendency in the heavy duty truck service, in contrast to Greases A, B, and C. It leaked markedly in one unit and to a lesser degree in others. At the time of inspection no grease or oil had reached the brake bands, but there were indications that this might happen on further service. The bearings lubricated with this grease showed various degrees of varnish formation. This grease also appeared to gel in the hub. A typical failing condition of Grease D after only 20,000 miles is shown in Figures 3a, 3b, and 3c. It will be noted also in Figure 3b that there was only a small amount of grease in the vicinity of the rollers.

In the light of these findings, it is apparent that the standard laboratory tests do not adequately predict field performance of bearing greases. These tests measure changes in certain physical properties that occur over a very short time interval under conditions hardly representative of actual service. Very possibly slow phenomena such as absorption of moisture, repeated heating, and subsequent phase transitions occur in service and might cause a structural breakdown leading eventually to excessive leakage. The laboratory tests are therefore to be considered as short term screening tests that eliminate obviously unsatisfactory products.

In an effort to simulate the long term working of a grease in a bearing, 100,000 stroke penetration tests were run on each of the four greases. Greases A, B, and C softened by 113, 98, and 154 mm./10, respectively, while Grease D softened only by 45 mm./10. These results would generally be interpreted in favor of Grease D, an interpretation directly opposed to the field test results.

Further evidence of the inability to simulate field conditions even by prolonged working in the grease worker has been obtained from a comparison of electron micrographs. Samples of the test greases were taken before and after working them for 100,000 strokes, and from the close vicinity of the balls or rollers of the passenger car and heavy duty truck bearings. The specimens were prepared following the technique described by A. Y. Mottlau[1] and examined under an electron microscope at 18,000X magnification. Figure 4 shows a comparison of the fiber structure of the original Grease B with that after working the grease 100,000 strokes, and after service both in passenger car and heavy duty truck bearings. While very little change, if any, is noticed after 100,000 strokes, the fiber size is reduced to about one-tenth both in width and length after service in the passenger car bearing. In the truck bearing no fibers could be distinguished even at higher magnification indicating nearly complete fiber breakdown. The same conditions prevailed for Greases A and C. Figure 5 shows that similar results were obtained with Grease D. None of the presently accepted laboratory tests appears to simulate completely actual bearing service conditions. They do not predict the actual performance of a wheel bearing grease in all possible applications, but they are useful as screening tests. We know of no other laboratory tests which give better predictions of field performance.

D. Analysis of Wheel Bearing Grease Failures

The field tests were run under carefully controlled conditions employing optimum lubrication practices so as to measure the performance characteristics of the greases per se. In actual service, complaints on grease performance may be encountered which are due to poor lubrication practices. In these cases, the grease is not at fault. Recognition of some of the malpractices along with their manifestations in the field will serve to explain many of the reported grease failures. The most common of these are discussed below.

Overpacking of the bearing assembly with grease will

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cause leakage. No room will be left for expansion during heating in service, and the grease will break through the seal and splatter eventually onto the brake drum. Such a condition is shown in Figures 6a and 6b. It will be noted that the hub is still full of grease even though a considerable amount has leaked through the seals.

It is more difficult to find the cause of leakage complaints if no obvious overpacking can be observed. One possible cause can often be traced to the overpacking of the brake actuating camshaft, since the mechanic lubricating the unit does not see how much grease he has applied to this point with his gun. Such a situation is shown in Figure 6c.

Another possible cause has been found to come from the leakage of the hydraulic brake fluid from the brake cylinder. This condition can simulate a grease failure, since the fluid penetrates readily into the bearing assembly and can cause contamination and liquefaction of the wheel bearing grease. This contamination should easily be detected by odor and chemical analysis.

E. Analysis of Bearing Failures

Premature bearing failures were not observed in these field tests. This might be due to the thorough control of test conditions and good lubrication practices observed. It is generally recognized that when unexpectedly rapid wear is observed, it often can be traced to metallurgical deficiencies, such as metal chips breaking off. This condition is caused by imperfections in the metal surface of the bearing that will not be detected by visual examination of a new bearing, particularly when they are covered by the cage holding the rollers in place. It leads to uneven wear on the roller and race surfaces. This type of wear is entirely different from that which one would expect to see if poor lubrication were responsible. In the latter case, the wear should be uniform over the entire outer race and roller surface.

F. Fretting Corrosion

Fretting corrosion has become increasingly important in recent years. At the site of the inner and outer bearings on the spindle, one observes occasionally the formation of reddish-brown corrosion products. The extent of this fretting corrosion varies from spindle to spindle but is more pronounced in those areas of the spindle and bearing that carry the major part of the load. It is least severe in passenger cars and most pronounced in heavy duty trucks. In extreme cases this corrosion can lead to a freezing of the bearing to the spindle with the eventual loss of both bearing and spindle, which is quite expensive. The cause of this corrosion in wheel bearings is believed to be due to the oscillatory motion of the bearing around the spindle with very close contact of both in the lower third of the spindle due to the weight distribution. If the bearing would turn relatively freely around the spindle, an even weight distribution would be achieved, and no fretting corrosion would occur. However, by attempting to achieve such a condition, one loses the properties of roller or ball bearings and regresses to a sleeve type bearing for which neither part was designed.

Many investigators have looked into the problems from both the lubrication and metallurgical angle, since this form of corrosion is not limited to wheel bearings alone. In general, it appears that the application of a soft grease of about 0 grade will be most effective in preventing fretting corrosion. Unfortunately, such a grease would be a very poor wheel bearing grease from the leakage

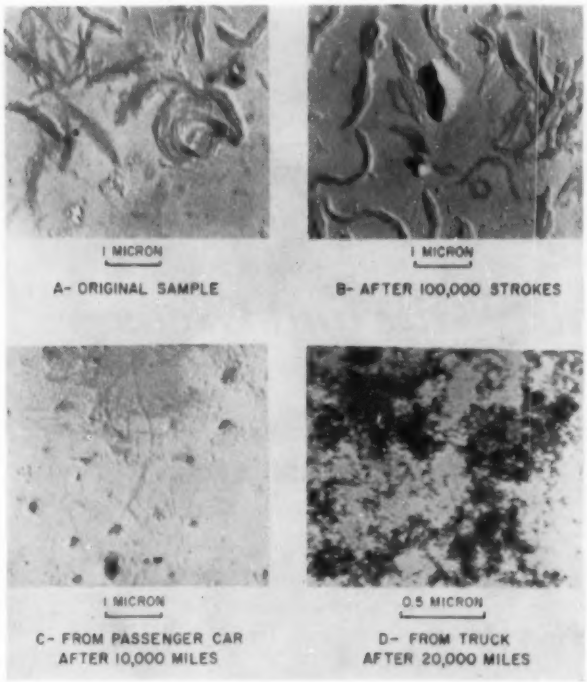


Figure 4—Grease B

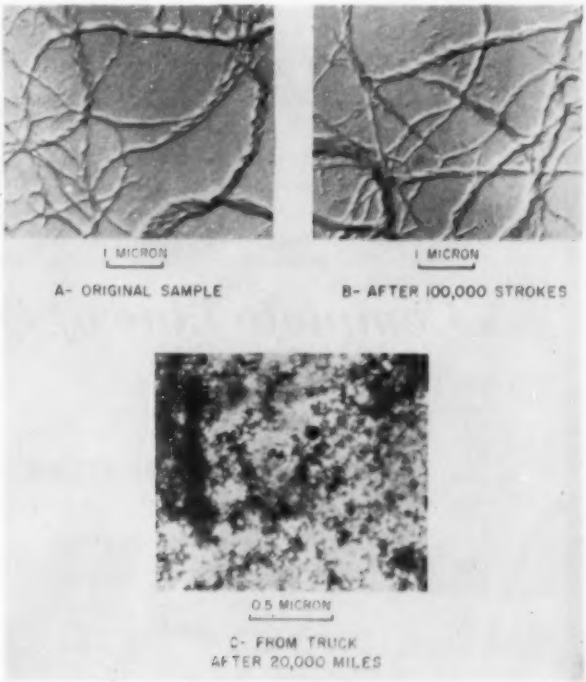


Figure 5—Grease D

Figure 6A—Spindle of an Overpacked Bearing.

Figure 6B—Hub of an Overpacked Bearing.

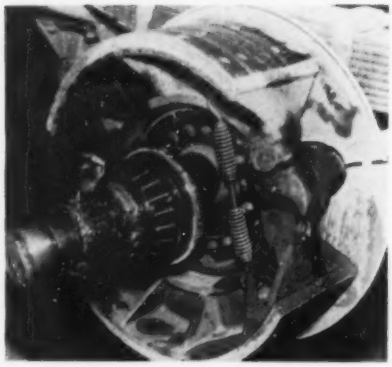


Figure 6C—Overgreasing of Brake Actuating Cam Shaft.

viewpoint. A possible solution of this problem could well be found in either the addition of appropriate additives to the grease or metallurgical improvements of the bearing. In the meantime, some improvement was achieved by applying a thin film of grease to the spindle, thus preventing metal-to-metal contact of the bearing with the spindle.

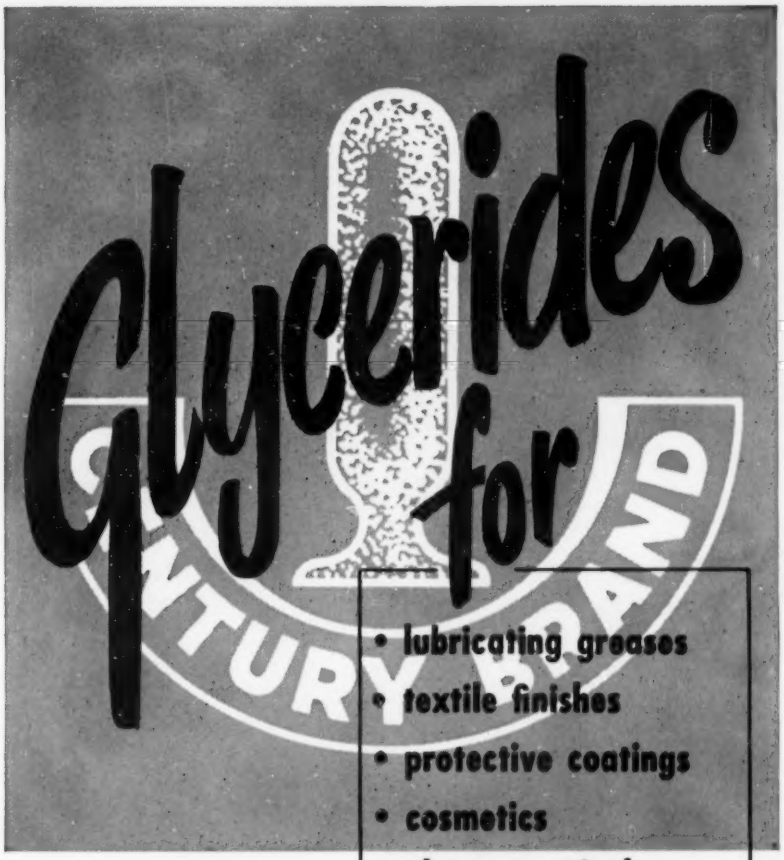
Conclusions

The performance of wheel bearing greases in service can be defined only by carefully designed field tests covering a wide variety of conditions. The commonly accepted laboratory tests are useful as screening tests to eliminate obviously unsatisfactory products. Good performance in the laboratory tests, however, is not a guarantee of adequacy in all wheel bearing grease applications.

Commonly occurring wheel bearing grease complaints can often be traced to poor lubrication practices. Complaints on leakage of greases may result from overpacking of the bearing assembly, from over-lubrication of the brake actuating camshaft, as well as from leakage of the hydraulic fluid from the brake system. Premature bearing failure in the majority of cases can be traced to metallurgical imperfections in the bearing. The problems of fretting corrosion can be alleviated to some extent by the application of a thin film of grease between the spindle and the bearing.

The field test results also indicated that these greases provide a very wide safety margin when the most generally recommended 10,000 mile relubrication period is followed.

1. A. Y. Mottlau, J. Appl. Phys. 20, 1055 (1949)



CENWAX G *(hydrogenated castor oil)*

CENWAX G is a glyceride chemically, although physically it resembles a wax. It is a hard, high melting point solid, available in finely beaded form, with practically no taste or odor. Typical applications are in lithium, barium or sodium greases; hot-melt paper coatings; extender for higher priced waxes in polishes. These CENWAX G specifications should suggest other uses:

F.F.A. (as Oleic Acid)	2.0 max.
Acid Number	4.0
Saponification Number	176-184
Iodine Value (WIJS)	1-5
Melting Point (°C)	82-85
Hydroxyl Value	155-165
Acetyl Value	137-148

CENTURY HYDREX 360 *(hydrogenated tallow glyceride)*

This hardened tallow product is available in beads and its good color, high titre and low iodine value particularly suit it for use in certain textile finishes and lubricating greases.

SPECIFICATIONS

Titre	(136.4-140.0°F) 58-60.0°C
Iodine Value (WIJS)	1-3
Free Fatty Acid	1-3%
Acid Number	2-6
Saponification Value	190-195
Color 5¼" Lovibond Column (Max.)	15 Yellow-2 Red

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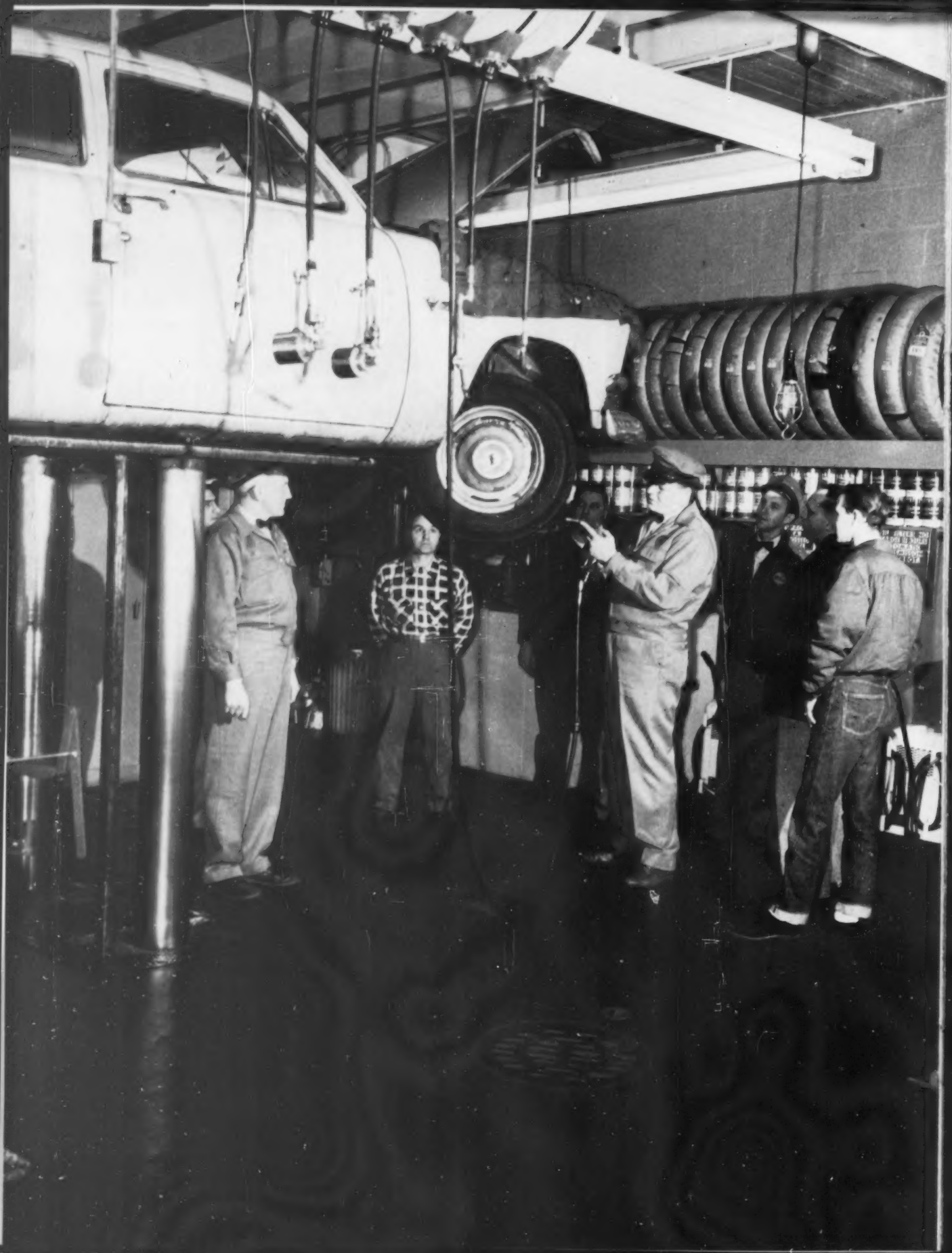

Shell's Training Program

AIMS AT GIVING DEALERS WHAT THEY WANT TO KNOW

Reprinted from the February 17, 1954 issue of *National Petroleum News*, a McGraw-Hill publication

Shell Oil Company launched a new approach to dealer training last month when its Detroit division opened their 1954 dealer training program.

The course is designed to give the dealer freedom in selecting his own courses and offers almost any subject the dealer may need. These include: driveway service; lubrication; TBA service and selling; salesroom, outside and luberoom display; station housekeeping; and management, bookkeeping and stock control.

Dealers get individual instruction in all of the courses, and refresher courses are available for veteran dealers.

The program originated in Shell's Detroit division and has become so popular that the company is making it available to all other divisions in the country.

Under the supervision of William Penman, Detroit division retail merchandising manager, the present training procedure was set up by A. A. Martin, division representative in charge of training.

How It Operates

The program works like this:

Classes are conducted every week on Monday and Tuesday in Detroit, Saginaw and Grand Rapids.

Shell district merchandising representatives act as instructors at each of the three schools. Each instructor spends two days a month in classroom instruction. Thus, instructors bring actual field experience into the classroom and are constantly alert to dealer training needs.

All Shell dealers, dealer salesmen, prospective Shell dealers, and Shell jobber salesmen, jobber dealers and jobber-dealer employes are eligible to attend. Time spent at the school is up to each dealer. He may select only the courses he wants.

Training prospect Earl Treadway listening to Robert Perry, Shell district salesman, explain training program.

Instruction has begun and trainee Treadway learns fine points of universal joints and how they are to be lubricated. Student is given thorough instruction in lube technique before putting his knowledge to practice in the school lube bays.

Chassis lubrication is being demonstrated in the school lube room, using Balcrank overhead reels. Instructor is explaining workings of lube gun to class.

Training centers at Grand Rapids and Saginaw are completely equipped to cover every phase of TBA display, selling and service.

Light display in classroom tells where various bulbs are used in the station and the cost of each. Prices are given on uniforms also.

Restroom facilities are available in classroom for demonstrating proper housekeeping practices to service station dealers.

Training is made available to Shell jobber salesmen, dealers and employes at no cost other than sending a man to the school and boarding him while attending the two-day sessions.

Up to the Dealer

While Shell salesmen may assist dealers in selecting study courses, the final decision is the dealer's. Often salesmen do convince a dealer he needs training in a subject or subjects which he has not requested.

Each Shell salesman and all Shell jobbers in Michigan are supplied with application forms.

When calling on a dealer, the salesman—or jobber—goes over the list of subjects with the dealer and his employes. Each man in the station checks the list for subjects he wants to study.

The form is returned filled out to the district office and a date set for training. The salesman—or jobber—in turn, notifies each dealer when he will attend school. Insofar as possible, classes are kept to a maximum of seven trainees and a minimum of five.

When a student arrives in class, the instructor checks the training schedule on file and notes the subjects requested by the dealer. Individual forms corresponding to the subjects requested by the student are attached to the student's training schedule. Each form carries the student's name and location.

Each subject form is made up as an outline to be followed by the instructor. As the student completes each study, it is checked off. On the lubrication form is a master chart upon which the instructor indicates whether a subject has been completed or if further instruction is necessary.

If a student wants to return to school another week, the file shows what ground has been covered already, thus avoiding repetition of subjects.

Each student is given individual instruction on only the subjects he has requested. Once he has completed these subjects he is free to leave.

Accent on Profit

Shell emphasizes that every subject taught has a two-fold purpose—improved service and more profit for the dealer.

Making the training flexible enough so that dealers may select their own subjects has proved one of the most popular features. Shell jobbers also feel that this makes available to the Independent marketer the type of training which, for the most part, has been open only to major company dealers. Jobbers have long felt that lack of adequate training facilities has placed them at a competitive disadvantage with major company stations.

Consensus of dealers is that generally they avoided—in the past—most training schools because they had to sit through classes on subjects they already knew or did not need. The Shell program, they say, eliminates that objection.

Shell's training center in Detroit is at a company-operated station at Woodward and Hazelwood.

grease manufacturers

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Titre	54.0°—54.5°C.
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Color 5¼" Lovibond Red	0.3—0.7
Color 5¼" Lovibond Yellow	1.5—2.5
Unsaponifiable	0.05% max.
Saponification Value	209—212
Acid Value	208—211
Iodine Value (WIJS)	5.0—6.5
Mineral Acid	None

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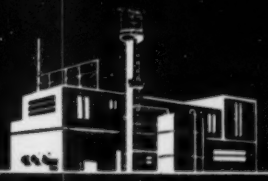

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Technical Committee

Chairman T. G. Roehner, Director of the Technical Service Department, Socony-Vacuum Laboratories

Plans for the activities of the NLGI Technical Committee during the October meeting in San Francisco are taking definite shape. It has been decided that a Symposium will be organized on "The Structure of Lubricating Greases." Mr. L. C. Brunstrum, of Standard Oil Company (Indiana), is Chairman of the Symposium Subcommittee. The Subcommittee will take care of the agenda and other organizational details connected with the presentations of short introductory papers and subsequent discussion periods. This Symposium is actually a cooperative effort with the main NLGI Program Committee. The entire afternoon of the first or second day of the meeting will be reserved for the Symposium. In other words, more time will be available for this Symposium than was provided in the two previous meetings. The membership of the Symposium Subcommittee will be given in the next issue of this column. In the meantime, any member who has suggestions concerning speakers and organizational details is urged to write direct to Mr. Brunstrum, whose address is:

Standard Oil Company (Indiana)
Research Department
Whiting Research Laboratory
P. O. Box 431
Whiting, Indiana

The morning of the third day of the meeting will be assigned entirely to reports of the Chairmen of the Subcommittees of the NLGI Technical Committee and there will therefore be more time for discussions of each Subcommittee's program and problems. It is already known that some of these programs present important questions which have decided pro and con aspects. The additional time will be required to give those questions the attention they merit.

Quaint cable cars climb San Francisco's storied hills, bells clanging merrily away. This is a gay experience—typical of San Francisco the 1954 NLGI Convention city.

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METASAP* ALUMINUM STEARATES make specialty greases 6 WAYS BETTER

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Patents and Developments

Alkylated Polystyrene Grease

Alkylated polystyrenes have been prepared with molecular weights ranging at 10,000 to over 150,000. In U. S. Patent 2,661,335, Monsanto Chemical Company describes an improved grease containing a petroleum fraction and 1–20% of a fatty acid soap with 0.01–5% of a compound made by the alkylation of a polystyrene having a molecular weight between 150,000 and 1,000,000, the alkyl group of the latter having at least 4 carbon atoms and a total substituent having an average of 6-12 carbon atoms per styrene ring.

It is pointed out that alkylated polystyrenes retain their molecular weight during shear much better than polyisobutylene. They also are claimed to be tackier, so that the greases produced possess improved adhesion to bearing surfaces and do not spatter when subjected to sudden loads or impact.

Diamine–Phosphorus Ester–Containing Greases

Difficulties are claimed to have been encountered in the uniform incorporation of N, N′-diphenyl-p-phenylene diamine into grease compositions of the sodium myristate type for ball and roller bearing lubrication. The operation is readily accomplished according to The Texas Company's patent 2,663,691, by adding the diamine in solution in an oil-soluble ester of a phosphorus acid, such as tri-alkyl, aryl and mixed alkyl-aryl esters boiling above 400° F. A suitable solution is tricresyl phosphate containing the diamine in the weight ratio of 2.7:1 to 4:1. At 200° F., the ester dissolves a little over one-third of its weight of the diamine.

Test data are submitted purporting to show excellent thermal stability when 0.1-8% of the diamine is used.

In U. S. Patent 2,663,690, this type of diamine inhibitor is used in a sodium myristate grease of the type disclosed in U. S. Patent 2,542,570. The inhibitor was compared with others, and Table I shows its superiority at high temperatures.

TABLE I

High Temperature Performance Test

Additive	*Hours to Failure* 425° F.	300° F.
None		219
1% Hydrazobenzene		326
5% 4-methyl-2,6 ditertiary butyl phenol	24	697
3% Zinc dibutyl dithiocarbamate+2% Ba phenolate		358
8% Hydrazine alkyl salicylate+2% Ba phenolate		264
1% 2,4-ditertiary butyl phenol+2% Ca isoamyl octyl o-phosphate		543
1% Diphenylamine	23	392
5% Diphenylamine		428
3% Diphenylamine +2% 4-methyl-2,6-ditertiary butyl phenol		524
1% Triphenylguanidine		452
1% p,p′-Diamino diphenyl methane	9	
1% s-Diphenylethylenediamine		288
1% Diethylenetriamine		251
5% Isopropoxy diphenylamine	12	
4% p-Phenylene diamine	11	
1% di-b Naphthyl p-phenylene diamine		645
5% di-b-Napththyl p-phenylene diamine	24	
2.5% N,N′ Diphenyl p-phenylene diamine	47	
5% N,N′ Diphenyl p-phenylene diamine	48	1056

The effect obtained by adding N,N′-diphenyl-p-phenylene diamine to the sodium myristate grease was almost twice that obtained by any of the other compounds tested.

Lithium Soap Grease Containing Methacrylate Ester Polymer for Bearing Noise Suppression

Lithium soap lubricating greases (such as those covered in U. S. Patent 2,450,221), have found substantial use in aircraft controls and for operation over a wide temperature range. While they have proved eminently satisfactory in service, some objection has been encountered in certain applications involving lubrication of ball bearings operated at high speed due to development of a high pitched metallic rattle or noise. This has been found to be characteristic of such lithium soap greases prepared with a synthetic lubricant base. On the other hand, such greases made with conventional mineral lubricating oil base develop merely a low pitched purr or hum in the lubrication of ball bearings operated at 2000 rpm. Particularly when a large number of the ball bearings are confined within a small or enclosed space, the high pitched metallic rattle has proved so objectionable as to cause ball bearing manufacturers to reject the grease even though other lubricating properties are superior.

In U. S. Patent 2,666,033 issued to The Texas Company, a lithium soap grease is disclosed which is claimed to be free from objectionable noise in such service. This grease contains 0.3-5% by weight of a polymerized methacrylate ester such as Acryloid HF, made by Rohm & Haas Co. Acryloid HF 600, 880, and 1300 were found to be most suitable when used with a mixture of mineral oil and di-2-ethyl hexyl sebacate and a lithium soap of hydrogenated castor oil and stearic acid.

It is believed that the heating of the polymer in the presence of the soap mix and a portion of the mineral lubricating oil may effect further polymerization as well as intimate, dispersion which enables the resultant lithium grease to better retain a sufficiently thick adherent film on the balls and races of the bearing when operated at high speed, to produce the satisfactory low-pitched purr and avoid the objectionable high-pitched rattle.

News Items

Alpha offers Molykate BR$_2$ extreme pressure grease for highly loaded ball and roller bearings and sliding friction surfaces. The compound is an oxidation-inhibited lithium base product fortified with molybdenum sulfide, and is claimed to operate at −30 to 350° F. (Chem. & Engrg. News 11/23/53 p. 4921).

E. Swakon, NLGI, claims that tests demonstrated the utility of aryl urea silicone greases. Many aryl ureas melt above 600° F. and are more stable than alkyl ureas (Chem. & Engrg. News 11/16/53 p. 4776).

Oxidized petroleum wax forms superior grease base. Sodium base grease gives excellent results in high temperature service–Kirk et al (Oil & Gas J. 1/11/54 p. 97).

Westvaco Chemical Division is advertising availability of trischloroethyl phosphite as an additive (Chem. & Engrg. News 1/25/54 p. 331).

NLGI Associate and Technical Mem

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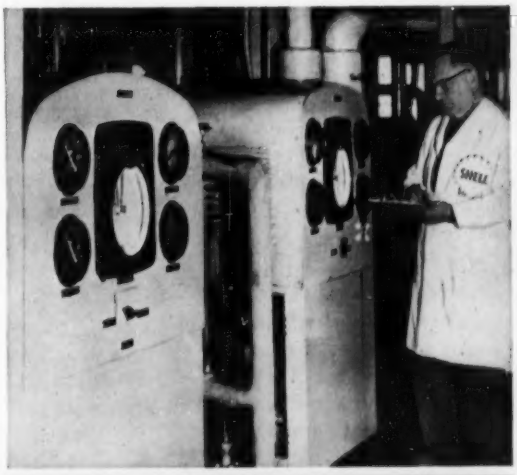

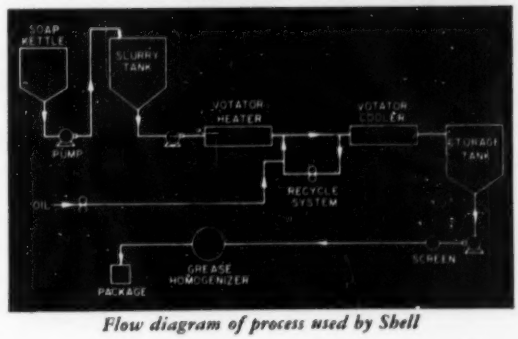

Flow diagram of process used by Shell

PEOPLE in the Industry

Emery Announces Opening of Direct Sales Office and Warehouse in Cleveland

J. A. FUNK

W. J. SIEMENS

W. C. SOWERS

After many years of servicing its northern Ohio accounts through Schibley and Ossmann, Inc., Emery Industries, Inc., of Cincinnati, has announced the opening of a direct sales office and warehouse in Cleveland on April 1, 1954.

According to R. F. Brown, Emery's chemical sales manager, this change has been brought about by the increased technical sales and service demanded by the rapid expansion of product lines, particularly into specialized technical fields.

William J. Siemens, Jr., who has been handling specialty products in the northern Ohio area, and William C. Sowers have been assigned to the new Cleveland office. They will be responsible for the sale and service on all Emery products, including fatty acids and derivatives, plasticizers, textile oils and emulsifiers.

Because of Mr. Siemens' increased responsibility, the southwestern Pennsylvania and West Virginia portion of his previous territory will be added to that of James A. Funk, operating out of Cincinnati.

Walter Nay Drowns

Walter R. Nay, 51, Chicago regional manager for Mallinckrodt Chemical Works, drowned on April 6 in Florida, where he was vacationing with his family after attending the recent American Pharmaceutical Manufacturing Association meeting.

Mr. Nay joined Mallinckrodt in 1933 as assistant manager of the Chicago office, became manager in 1935, and in 1949 was named manager of the north central states region.

Mr. Nay was active in several chemical and drug industry associations. He was vice president of the Chicago Perfumery Soap and Extract Association in 1945 and president in 1946. After serving three terms as secretary of the Chicago Drug and Chemical Association, he became vice-president in 1949 and president in 1950.

Always conscious of his civic responsibility, he was president of the Flossmoor, Illinois, Park District in 1946, Chairman of the Drug and Chemical Division Committee for the Chicago Red Cross in 1945, and of a similar committee for the Community Fund in the same year. In 1946 he was Community Fund Chairman of the Manufacturers Division. He was also head of the Drug and Chemical Division of the Boy Scouts.

He was a member of the Chicago Athletic Association and Olympia Fields Country Club.

Mr. Nay is survived by his mother, Mrs. Frances Nay; his wife, Betty Burke Nay; a son, Marshall; two daughters, Mrs. Quinn Ogren and Mrs. Robert Phillips; two brothers, David and Marshall; and a grandson, Robert Phillips, III.

Gulf Honoring Long Term Employees

Diamond and ruby service award emblems and engraved certificates will be awarded to 3,424 veteran employees in all of the various domestic departments of the Gulf Oil Corporation this spring.

This makes a total of 16,625 active employees in the United States who have participated in the Service Awards Plan—or approximately 48% of Gulf's total domestic working force.

Employees become eligible for service awards after completing 10 years' service, and for each five-year period thereafter.

In a statement announcing this year's awards, Gulf's management said, "We deem it fitting and proper to publicly recognize our veteran

workers who have contributed so much to the company's success and growth over the years. These loyal employees," the statement continued, "and others like them in the oil industry, are going to be called upon to help in meeting the anticipated increase in demand of between 2% and 4% for petroleum and petroleum products in 1954."

Among the group to be honored this year will be one employee, Willard F. Jones of New York, who has served Gulf a total of 50 years. He is the second employee in company history to have recorded that number of years of service.

There will be three employees receiving 45-year awards; 31 receiving 40-year awards; 200 being honored as 35-year veterans; 533 with 30 years of service; 512 with 25 years; 915 with 20 years; and 361 with 15 years of service.

A total of 868 employees are entering the veteran group for the first time, having reached their first ten-year mark with Gulf.

One outstanding example of long service records is represented by the Pittsburgh, Pa., refinery, where 92% of the total employees there have service in excess of 10 years.

This marks the fifteenth year that Gulf has honored its veteran employees.

Shell Appoints Engineering Manager

J. G. Wilson, formerly chief engineer at Shell Oil Company's refinery at Wood River, Illinois, has been appointed manager of the manufacturing engineering department at the company's head office in New York, it has been announced. He succeeds W. F. Court who is retiring for reasons of health after thirty years service with the firm.

Wilson was born in Mexico and received a degree in mechanical engineering from the University of Michigan at Ann Arbor. He joined Shell in Mexico in 1933 as an assistant engineer and five years later was assigned to San Francisco. He became assistant department manager at New York in 1948 and chief engineer at Wood River in 1952.

Le Fevre Advances at Socony-Vacuum

Paul H. Le Fevre was elected an assistant treasurer of Socony-Vacuum Oil Company, Inc., at a meeting of the board of directors which followed the company's annual meeting of shareholders in April.

He joined the company in 1928 as a member of the foreign accounting staff. Later he served in the comptroller's department and in positions with Socony-Vacuum operations in South America. In 1952 he was named treasurer and comptroller of Socony-Vacuum Overseas Supply Company with headquarters at Fort Lee, N. J.

Mr. Le Fevre is an alumnus of New York University. His home is at Ho-Ho-Kus, N. J.

Technical Committee Representative

JOHN S. REARICK

John S. Rearick, who is the C. W. Nofsinger Company's new NLGI Technical Committee's Representative, took his undergraduate work at Hamilton College and received his Master's degree in Chemical Engineering from Columbia University. After service with The Dorr Company and The Columbia Refining Company he joined the Petroleum Research Division of The M. W. Kellog Company in 1937; in 1946 he was made Associate Director of Research. He was in charge of pilot plant design, construction and operating during the development of Fluid Catalytic Cracking, Hydroforming and various other petroleum and chemical processes. He also was responsible for the design of facilities for the commercial production of the fluorocarbon plastic known as Kel-F. Subsequently, he served as Development Engineer and as Division Engineer for The M. W. Kellogg Company. He is a member of the American Society of Mechanical Engineers, American Institute of Chemical Engineers, American Chemical Society, Instrument Society of America and the National Society of Professional Engineers.

Approximately 1,000,000 miles of America's local roads, or 40 per cent of the total mileage, are used by less than ten vehicles daily.

Shown making reservations for their recent trip to the Orient are Norman W. F. Klein, director of exports of Morehouse Industries, and Jolly Joe Taylor, consulting engineer for Morehouse. While in Osaka, Japan they supervised the Morehouse exhibit in the Osaka Machinery Industrial Fair.

Battenfeld Promotes Gee

Robert M. Gee has been promoted to Sales Manager, waterproofing division, of Battenfeld Grease and Oil Corporation. Mr. Gee has been with the corporation a number of years. He returns to Kansas City from Battenfeld's Minneapolis territory, where for the past few years he has served as sales representative.

Robert Todd, who has been working in the various departments of the plant, replaces Bob Gee in Minneapolis.

R. S. Nowell, formerly in charge of waterproofing sales, is leaving to manage Battenfeld's west coast plant.

Baggiani New Morehouse Representative

Morehouse Industries announces the appointment of the M. B. Sweet Co., Chicago, to act as their sales and service representatives in Northern Illinois and Wisconsin. The Sweet Company is headed by Merle B. Sweet and Julius A. Baggiani, partners. Baggiani, who will be in sole charge of the Morehouse operation, has just returned from Los Angeles where he received intensive factory training in the operation, maintenance, and use of the Morehouse Mills.

Active in the paint industry since 1937, Mr. Baggiani was formerly vice president and sales manager of the Philip E. Calo Company. He has also been associated with the Kohler-McLister Paint Company, Denver; Armstrong Paint and Varnish Works; and the G. J. Liebich Company. His experience includes control of varnish

JULIUS A. BAGGIANI

W. J. MAJOR

J. E. QUINTY

manufacture, production control and research as production manager, formulator of trade sales items, salesman, and sales manager.

Griffin Assumes New Duties

Everett J. Griffin has been appointed assistant to the vice president in charge of marketing for the Shell Oil Company, it has been announced. In the newly-created position, Mr. Griffin will assist in the coordination and administration of the firm's marketing activities from coast to coast.

Mr. Griffin was formerly manager of Shell's Cleveland marketing division. He is being succeeded there by John H. Hall, previously marketing operations manager in the company's New York headquarters.

A Shell employee since 1930, Mr. Griffin has served as sales manager for several Shell marketing areas in the Northwest and on the West Coast, and in 1941 he was made assistant to the sales manager of Shell's San Francisco office. He became manager of the Cleveland division in 1951.

Emery Appointments

Emery Industries Inc. announced that J. E. Quinty has now assumed sales responsibility for all of Emery's fatty acids and derivatives, plasticizers, and textile oils in Northeastern Pennsylvania and parts of Northern New Jersey. He had perviously been assigned to the home office sales staff.

At the same time, R. R. Brown, Emery's Chemical Sales Manager, also announced the appointment of W. J. Major to the chemical sales staff.

Mr. Quinty attended Bowling Green State University and obtained a B.S. degree in chemical engineering from Purdue University.

Mr. Major was formerly associated with the Technical Division of General Electric at their Hanford Atomic Energy Works. His education includes a B.S. degree in chemistry from the University of Colorado.

Cunningham to Sales

James E. Cunningham, who entered the employ of Witco Chemical Company in 1944 as a laboratory technician, has been appointed to the New York sales staff.

Mr. Cunningham advanced from laboratory technician to manager of Witco's Brooklyn stearates plant.

Industry NEWS

Du Pont Dedicates New Laboratory

A new laboratory building for expanded research on safe-guarding the health of its employees and the users of its products was dedicated by the Du Pont company recently.

The $2,000,000 structure provides enlarged facilities for the company's Haskell Laboratory for Toxicology and Industrial Medicine. The 50-member staff is already in the new quarters.

Early work of the laboratory, although novel at the time, was concerned almost entirely with learning the toxicity of certain products. It has developed now to include a major research effort in industrial preventive medicine, concerned with maintaining the health of man at his daily work.

The Du Pont scientists are probing such secrets as the causes and effects of fatigue, basic factors that make clothing comfortable, and methods for the early determination of abnormal heart conditions, as well as investigating the toxicity of chemicals made or used by the company.

The new Haskell Laboratory is a single story, air-conditioned building of 33,000 square feet, located near Newark, Del., about 17 miles from Wilmington. Facilities include laboratories for toxicological, biochemical, pathological, physiological, and physical research.

On display was the toxicological work that is being done. When the laboratory was established in 1935 it was for rigidly testing Du Pont products and manufacturing processes to eliminate as far as possible every potential hazard to employees and customers. This activity has expanded over the years and is still expanding. Particular emphasis is placed on research that will reveal the very early physiological changes caused by the action of chemical compounds, so that adequate preventive measures may be set up in company plants.

As a result, some promising new products have been changed, or even abandoned, because of possible hazards to users. In some other cases, manufacturing methods have been changed to protect employees.

Also of major interest to the visitors was the operation of two all-weather rooms, in the more versatile of which scientists maintain temperatures ranging from 20 below zero to 200 above, plus wind velocities up to 20 miles per hour and humidity control. One of the few such installations in the world, the room provides a wide variety of weather conditions.

These rooms are important tools for developing knowledge in the largely unknown fields of causes and effects of fatigue and the basic factors of clothing comfort. The fatigue studies have already produced some results, which will also be illustrated, but the program is projected far into the future. Physiologists at the laboratory have been able to translate some of their knowledge into more easily done jobs at company plants.

In the research on clothing comfort, the scientists are trying to discover why fabrics make people comfortable or uncomfortable. They believe that, if they can find out why, they will be able to design clothing that will provide greater comfort under extreme conditions of heat and cold; that they will know how to make better fabrics and what fibers to use.

With the climatic control, they can create hot, muggy weather, stir up chilling breezes, plunge into dry desert heat, or make wintry conditions. Thus they can measure precisely the bodily changes caused by different atmospheric conditions in relation to types of fabrics worn by individuals; and can determine the effect of work on people under an extremely wide range of conditions.

ASTM to Exhibit Scientific And Testing Equipment

Many new and interesting pieces of scientific and testing equipment will feature the Eleventh Exhibit of Testing and Scientific Apparatus and Laboratory Supplies to be held at the Hotel Sherman in Chicago, June 13-18, during the 57th Annual Meeting of the American Society for Testing Materials. Leading manufacturers and distributors of instruments and laboratory supplies will emphasize the continued progress being made in providing research and testing engineers with suitable facilities for evaluating the properties of all kinds of materials. There will be new and improved types of equipment covering the determination of the mechanical, physical, electrical, optical and chemical properties of materials of all kinds. Various types of non-destructive testing will be featured.

This exhibit affords all those concerned with research and testing work, whether of a production, control, or research nature, to see concentrated in one place many of the newer developments in the apparatus field.

Adjoining the apparatus exhibit will be the Ninth Photographic Exhibit in which members of ASTM and member companies will display photographs related to the theme: Materials, Testing, and Research. A large number of extremely interesting prints and photomicrographs will be shown.

Anyone interested is cordially invited to attend both apparatus and photographic exhibits.

U.S. Steel Hour

The United States Steel Hour has been named "Show of the Year" by TV Guide for "outstanding achievement, initiative, and enterprise and a major contribution to the industry," the national television weekly has announced. Presentation of a Gold Medal Award was made to J. Carlisle MacDonald, assistant to the chairman of United States Steel, by Oliver Crawford of the editorial board of TV Guide.

The Steel Hour is one of three shows to be selected for this special honor, the other two being Edward R. Murrow's "See It Now" and "Cavalcade of Sports."

Educational Plan

Interest in further education ran high last year among employees of Socony-Vacuum Oil Company, Inc., and its affiliates, as measured by the number who took part in the company's educational refund plan.

A total of 663 men and women completed courses during the year, the largest number since the plan was instituted more than 20 years ago

Under the plan, the company shares half the costs of tuition, books and equipment with employees continuing their education in their spare time. Socony-Vacuum believes such help encourages self-improvement which benefits both the individual and the company.

Oil Industry Continues To Expand

More than four billion 600 million dollars will be spent by the U. S. oil industry in 1954 to expand and develop its resources and facilities to meet the increasingly heavy demands of both the present and the future. This was announced recently at a meeting of the Board of Directors of the American Petroleum Institute in New Orleans. The estimate for 1954 is based on the Institute's biennial survey of petroleum capital expenditure programs. Details of the latest survey were made public in New Orleans.

President Frank M. Porter said this is the greatest single sum of money ever earmarked for such purposes in any one year of petroleum history. He termed it a clear manifestation of the oil industry's faith in America, and in the current and future business outlook.

"Virtually all of this vast 1954 investment will be spent in the United States," he said. "Only a little over 600 million dollars is scheduled for foreign use, leaving the bulk of more than 4 billion for expansion, modernization and development in this country.

"This constitutes a record in itself, for this is the first time that oil's capital programs have exceeded four billion dollars domestically in any calendar year. The 1953 home peak was three billion 856 million dollars.

"The size of these financial commitments and the fact that they are only a one-year segment of the industry's continuing process of modernization and expansion point up two things, in addition to oil's expression of faith in the future—that the companies recognize and are discharging their responsibilities with traditional foresight, and that they are keeping themselves geared and prepared, for peace or war."

In addition, the API president continued, 1954's huge investment of four billion 619 million dollars raises the oil industry's post-war total for capi-

tal expenditures to more than 28 billion dollars. This post-war total, he said, is equivalent to double the total investment in plant and equipment of the whole U. S. oil industry in 1945, when it was almost single-handedly fueling and lubricating the mighty war machine created by this nation and its allies.

The 1954 estimate represents an increase of six per cent over last year's high of four billion 349 million dollars, Porter noted. He also expressed belief that the forecast may be somewhat low since the record shows that API's preliminary estimates have been on the conservative side.

Discussing the specific results of the survey, which the Institute makes biennially as a service to the industry, the government and the public alike, the oil industry executive continued:

"These billions will be spent in many ways by the oil companies and oil men. They will be used for leases, wells and equipment; for natural gasoline and cycling plants and other forms of production. They will be used for pipe lines to move crude oil, products and natural gas; for tankers and barges, tank cars, motor transport and other forms of transportation; for new and enlarged refining facilities, fertilizer and chemical plants, distribution outlets and other types of marketing operations.

"All of these activities, of course, will require a vast and continuing flow of steel and other basic materials, machinery, equipment and innumerable other supplies and commodities. The expenditures involved are bound to have a healthy and resounding impact on the business prosperity of the supplying communities, and the economy of the country as a whole."

Porter pointed out that the immensity of the over-all program is a fair indication of the petroleum industry's staggering financial requirements. The bulk of this money, he said, must come from the earnings of the thousands of companies which make up the U. S. oil industry. The ability of oil companies and oil men to encompass these requirements is a striking illustration of what free capital and free enterprise can do when they are left alone to work out their own affairs, he said.

The API survey showed that, in keeping with tradition, the lion's share of the four billion dollars assigned for domestic purposes will go to production and development. The 1954 estimate calls for the expenditure of two billion 349 million dollars.

The survey also shows that the refinery expansion program is goint to continue making big strides. A record-breaking total of 845 million dollars has been earmarked for this purpose in 1954—up more than 136 million over last year's figure. This program reflects the government's desire for the industry to have a reserve "cushion" to meet national defense requirements, in case of emergency, as well as for normal growth, the API president said.

OIL INDUSTRY CAPITAL EXPENDITURES IN 1954, 1953, 1952 AND 1946-51

(In Thousands of Dollars—000 omitted)

	Estimated 1954*		*Actual* 1953*		*Actual* 1952*		*Actual* 1946-51*	
	United States	*Foreign*	*United States*	*Foreign*	*United States*	*Foreign*	*United States*	*Foreign*
PRODUCTION								
Crude Oil								
A. Leases	369,146	30,783	411,499	34,361	395,858	22,004	1,399,020	96,830
B. Wells & Equipment†	1,658,584	392,388	1,596,429	311,869	1,675,636	303,517	5,826,790	1,141,140
Natural Gas								
A. Leases	13,741	.....	13,276	82	22,297	395	52,390	230
B. Wells & Equipment†	62,078	2,384	87,963	1,572	60,228	2,366	209,630	6,980
Natural Gasoline & Cycling Plants	143,682	279	108,723	.....	85,175	.....	371,450	280
All Other	102,643	10,960	84,130	14,012	86,768	19,226	156,990	76,450
Total Production	2,349,874	436,794	2,302,020	361,896	2,325,962	347,508	8,016,270	1,321,910
TRANSPORTATION								
Pipe Lines								
Crude Oil Lines	87,286	15,247	137,294	3,915	216,875	35,786	694,160	115,590
Product Lines	95,427	.....	106,752	16,424	131,017	.....	308,460	.....
Natural Gas Lines	17,423	881	21,962	446	18,544	2,136	119,963	10,880
Marine								
Tankers	68,186	9,200	73,782	8,471	54,154	19,344	418,260	107,490
Barges	14,331	.....	23,126	.....	11,784	.....	33,850	150
Others	1,423	.....	1,392	.....	1,519	.....	30,430	60
Tank Cars	19,259	337	7,388	2,897	24,870	217	79,310	40
Motor Transport	8,648	202	13,356	233	12,050	401	71,750	2,050
All Other	2,583	352	4,464	227	3,355	903	53,100	1,620
Total Transportation	314,566	26,219	389,516	32,613	474,168	58,787	1,809,283	237,920
REFINING	845,994	91,722	709,253	60,910	535,629	41,961	2,095,620	253,320
FERTILIZER & CHEMICAL PLANTS	66,531	.....	65,382	.....	45,925	.....	138,560	.....
MARKETING	370,366	44,339	329,133	30,614	299,235	35,032	1,359,400	144,010
OTHER	66,868	6,101	60,952	7,216	59,753	3,398	263,855	7,857
Grand Total	4,014,199	605,175	3,856,256	493,249	3,740,672	486,686	13,682,988	1,965,017
	(4,619,374)		(4,349,505)		(4,227,358)		(15,648,005)	

*Figures on foreign capital expeditures include those made for consolidated subsidiaries only.
†Includes expenditures for intangible development cost of producing wells and dry holes whether capitalized or charged to earnings.

Chek-Chart Publishes 25th Anniversary Edition

The 1954 Guide to Approved Lubrication for Passenger Cars and Light Trucks, just published by The Chek-Chart Corporation of Chicago, Illinois, is the firm's twenty-fifth anniversary edition. It contains 146 pages of charts, instructions and special pages.

More than 85% of all passenger cars in use are covered by the charts included in the 1954 editions. In terms of years, coverage extends from 1954 models back through 1942 for all makes; back through 1939 for Chevrolet, Ford and Plymouth. Most of the light trucks in use are similarly covered by a selected group of truck lubrication charts.

The first edition, published in 1929, included charts for 50 makes of passenger cars in order to cover the market. A total of 21 makes of cars covers the market in the 1954 edition. Sixteen of them appeared among the 50 makes covered in the first edition. The rest of the makes included in the original 1929 edition have slipped into oblivion. Remember these names: Auburn, Blackhawk, Chandler, Davis, Diana, Duesenberg, Durant, Elcar, Erskine, Essex, Falcon Knight, Franklin, Gardner, Graham-Paige, Hupmobile, Jewett, Jordan, Kissell, LaSalle, Locomobile, Marmon, Moon, Oakland, Paige, Peerless, Pierce-Arrow, Reo, Roosevelt, Star, Stearns Knight, Stutz, Whippet and Windsor?

In the 25-year span since the first lubrication guide edition, cars have changed tremendously. Lubrication charts, too, have been steadily improved by The Chek-Chart Corporation. The new, 1954 edition includes the unique "Work-Saver" lubrication charts which were introduced in the publisher's 1953 guide editions. These new charts, further improved over the previous year, are organized visually on the basis of how lubrication work is actually done. "Follow-the-chart" lubrication is actually easier than hit-or-miss methods, according to Ray Shaw, Chek-Chart president. The new format features a built-in procedure designed to make lubrication work easier and faster without sacrificing thoroughness or accuracy.

Augmenting the chart pages in the new, 1954 edition, there's a 13-page section of illustrated step-by-step procedures for servicing units and components shown on the individual charts. The section includes complete, up-to-date instructions (drain and refill; level check procedure) for all makes of automatic transmissions.

Two special pages, listing vehicle manufacturers' crankcase drain recommendation and exceptions to average drain interval recommendations, are included in the 1954 edition as a merchandising aid. Initial drain, second drain and regular drain recommendations are listed for each car and light truck manufacturer along with the manufacturer-stated exceptions.

The complete 146-page edition of CHEK-CHART'S 1954 Guide to Approved Lubrication is designed to work with lubrication men—close to the job. Wire spiral bound across the top, the edition can be folded over on itself at any page. With the special wire hanger included with each copy, the guide can be hung anywhere—under the car, on the wall—opened flat at any page.

Chek-Chart's New Guide

API Sponsoring Television Shows

A group of oil industry executives, and three motion pictures produced by the American Petroleum Institute, will be featured in a special series of documentary television shows to be aired this spring and summer, on the Du Mont network.

The 19-week series, dramatizing the benefits Americans receive from modern miracles in science and industry, started April 21, at 10:30 P. M. (New York time). They will be seen each Wednesday thereafter at the same hour. The show will be the "Better Living Television Theater."

Participating in the oil programs will be Frank M. Porter, president of the American Petroleum Institute; John M. Lovejoy, chairman of the board of Seaboard Oil Company of Delaware, New York; Fred M. Herlihy, president of Power Oil Company, Orangeburg, S. C., and Ladd Haystead, Agricultural Counsellor for the Institute.

The motion pictures to be seen are "Man on the Land," "American Frontier," and "Farm Petroleum Safety." "Man on the Land" tells the story of man's struggle through the ages to provide sufficient food and fibre to exist, and how the advent of oil-powered equipment changed the face of agriculture. "American Frontier" dramatizes the discovery of oil in Williston Basin, North Dakota, in 1951. "Farm Petroleum Safety" pinpoints the proper handling and use of petroleum products on the farm.

Short panel discussions will precede the showing of each motion picture, with Fischer Black, editor of Electrical World magazine, as moderator. The panel for "Man on the Land" will consist of Lovejoy, Herlihy and Haystead. For "American Frontier" the discussion will feature Fischer and Porter, and for the farm program, Fischer and Haystead.

The objective of the series is to dramatize behind-the-scenes facts of American business enterprise in such basic fields as nuclear energy, steel, oil, railroads, and so on.

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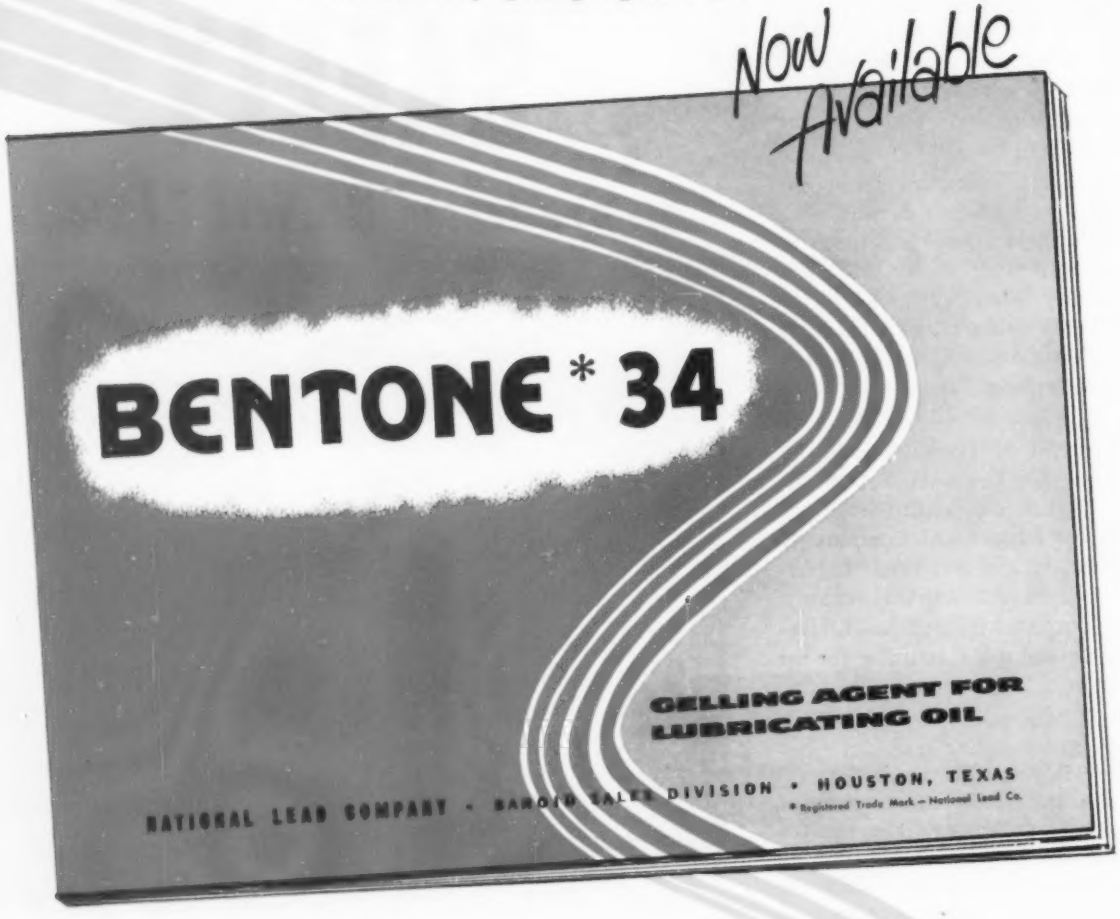

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Hood Optimistic About Construction Industry

U. S. Steel President Clifford F. Hood predicts a bright future for the country's construction industry, declaring that if building came to a standstill today the high rate of activity would make the past few decades look like the "Gay Nineties."

In an address before the thirty-fifth annual convention of the Associated General Contractors of America, Mr. Hood predicted that construction "expenditures by industry and government will continue to be high, but the brightest picture centers around the estimates of construction contract awards for the coming year.

"These indicate another $34 billion expenditure for new construction alone, and if the estimators are off in their calculations as they were in 1953, this figure could well approach $36 billion," Mr. Hood said.

Mr. Hood pointed out he felt construction would continue at a high level of activity for the following reasons:

1. The increase in population will be one of the most important factors in expanding our economy. In 1960, just six years from now, it is estimated the population will increase almost 20 million, totalling 180 million.

2. The movement of the population to the suburbs will mean the continued creation of new communities, with the construction of all the facilities they require, including highways.

3. Increased school enrollment will require a major construction program. Surveys reveal some 425,000 new classrooms will be needed by 1960.

4. Many of our cities are becoming obsolete and will require new construction and major traffic projects.

5. The potentials of the atomic age are "virtually racing in on us at this moment."

6. The entry of electronics into the field of industry with its "automation" operations opens a new field, calling for adaptation of our plants.

7. Research in the fields of physics and chemistry, "reaching 3-D proportions," stands as a challenge for growth.

Alemite Is Sponsoring Car Care Schools for Women

Automobile dealers who have envied the success of two dealers in Cleveland, O., in attracting women to their places of business to attend car care training courses, or the success of the Hartford Automobile Dealers Association's training course for women, now can duplicate these popular business-getting promotional successes.

"Gas, Gasket and Glamor,"—a complete package for putting new car dealers into the school-for-ladies program, and providing complete how-to-do-it outline for publicizing, setting up and conducting the course,—has been announced by F. A. Hiter, senior vice president of Stewart-Warner Corporation and head of its Alemite Division.

Women students learn about tire care in the service department of Commerce Motors, Cleveland, Ohio. Here the instructor is explaining the importance of wheel balancing, using an Alemite Wheel Balancer and a tire worn thin from unbalance.

Declaring that the Alemite school program for dealers provides a proven profitable and a virtually untapped approach to new car as well as service sales, Mr. Hiter emphasized that it is immediately available in every state through Alemite's distributors.

"This school plan will be a sure hit with the ladies who are responsible for the care of the family car and with their husbands who pay the bills. This was proved conclusively by the two Cleveland dealers when they announced their classes and found over four hundred women clamoring to be enrolled. The car dealers who sponsor Alemite's 'Gas, Gaskets and Glamor' school will have one of the best means in the automotive industry to build up their service and sales volume, not to mention the customer relations factor, which is of such great importance today," Mr. Hiter said. "It is the woman of the family who is charged with the handling of the household budget and it is she who has the power to influence purchases, whether they are bath towels or sky-blue convertibles. To educate the woman in car care is to help her control the family car expenses, one of the biggest items on the average budget. The value of this educational plan cannot be overestimated, any more than men can overestimate the power of the woman.

"There's many a car that would have been serviced before it broke down or deterioriated,—if the woman of the family had known what should have been done. Seeing that the family car is properly serviced is another family chore that the woman is ready to take over, as soon as she's made aware of why and what to do.

"I believe that enlisting the power of the woman represents the best means to the end of seeing that cars are lubricated when they should be, and serviced regularly. In educating the woman to the value of proper care the dealer has the opportunity to convince her, as well, of his ability to provide sincere, quality service. He will both increase service business and new car sales in so doing."

The course is presented in a "school book" which leads the dealer every step of the way in teaching women the proper care and maintenance of their cars. Demonstrations, films, charts and expert instruction in every phase of car use and car care are called for in the course outline.

Also covered are how to make minor repairs; emergency road service; basic mechanics; winter and summer driving preparations and precautions; periodic lubrication and preventive maintenance; how to choose and when to trade-in a car, and, many other details of car ownership and operation.

Trucking is now the second largest industry. California leads the nation with almost 700,000 truck registrations and Texas follows with 660,000. Pennsylvania has 470,000 and New York 450,000.

Alemite Announces New Catalog

A catalog of lubrication equipment especially designed for the servicing of lubricated valves has just been published by the Alemite division of Stewart-Warner Corporation. It is available from Alemite distributors and jobbers.

High pressure mechanical lubrication of lubricated valves, used by the chemical and process industries, pipe lines, refineries, tankers and barges and throughout most industries to some extent, offers money-saving advantages running upwards of fifty percent over hand lubrication methods, it is stated. It eliminates removing, replacing and turning lubricant screws generally found on lubricated valves. High pressure forces lubricant through all valve lube ports, regardless of back pressure, because lubricant is injected into valve direct from a gun or pump.

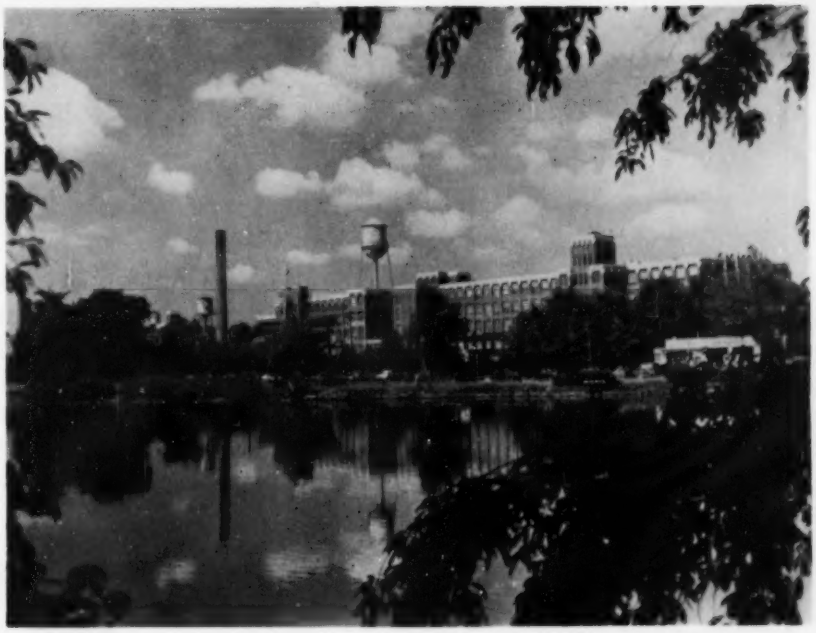
Citing the experience of industry that "80 percent of all service problems in lubricated valves are due to faulty lubrication" the catalog points out that thorough lubrication at regular intervals maintains positive seal, keeps valves free-operating against high pressures, and protects working surfaces against wear and corrosion.

Various types of lubrication fittings, which are inserted in the same threads in place of existing lubricant screws on lubricated valves; special extra heavy duty lubrication guns, both lever and bucket types; hose assemblies, follower plates, pressure gauges and other accessories are covered in the catalog, and their use explained.

Petersen to Make Address

An address, "Profits Are For Everybody," by T. S. Petersen, president of Standard Oil Company of California, will be one of the many special features of the midyear meeting of the Division of Marketing of the American Petroleum Institute in Denver, May 17-19.

The West Coast executive plans to discuss how profits are utilized on all levels of the oil industry, and what impact they have on local and general economies, according to an announcement by R. M. Bartlett, vice president of Gulf Oil Corp. and API vice president for Marketing.



W. C. Hardesty Company, Inc., have moved their main offices to new and larger quarters at 25 Main Street, Belleville 9, New Jersey, pictured above. The company, observing its 28th year in the fatty acid and chemical fields, was headquartered in New York.

"The full program for the Marketing Division's midyear meeting at Denver is being rapidly rounded into shape by our Program Committee of which J .G. Jordan, vice president of Shell Oil Co., is chairman," Bartlett said. "Full information on the program will be announced in the near future."

Foote Mineral Announces Further Lithium Expansion

The Directors of Foote Mineral Company have tentatively approved further expansion of facilities for the production of lithium ores and chemicals, Mr. H. C. Meyer, chairman of the board, said today. The proposed expansion, which has been under study for almost a year, will include major additions at the company's Kings Mountain, N. C. and Sunbright, Va. plants. Facilities at the Exton, Penna. plant will be increased to a lesser extent. Many of the present facilities were designed and built in the expectation of further expansion.

Mr. Meyer said that the probable cost of the proposed expansion will amount to several million dollars. The company expects to finance the cost of the new facilities through bank loans and does not contemplate any public financing at this time.

Monsanto Expanding

Monsanto Chemical Company is constructing facilities to increase production of detergent additives for lubricating oils, it has been announced by John W. Newcombe, petroleum chemicals sales manager for the company's organic chemicals division.

The added capacity is being erected at the division's W. G. Krummrich plant at Monsanto, Ill., and is expected to start up in September of this year, Newcombe said.

Detergent oil additives, which primarily reduce the buildup of engine deposits, are used in blending the so-called heavy duty lubricating oils, much in demand by automobile manufacturers and motorists.

The market for lubricating oil additives, latest figures indicate, will approach $110 million this year as compared with a little less than $25 million just after World War II. The increase is due to the greater need for lubricating oils which will withstand operating conditions of high-speed, high-compression engines, as well as to the use of larger amounts of additives in blending such fortified oils.

Industry Looks at Lithium

A new guide book on lithium and its compounds, is now available from Foote Mineral Company, Philadelphia 44, Penn. The guide book contains many new ideas and new applications of lithium chemicals, as well as a complete coverage of the current commercial applications of lithium compounds. Your lithium guide book will be mailed upon application to R. D. Drake, advertising manager, Foote Mineral Company, 18 West Chelten Avenue, Philadelphia 44, Penn.

Gasoline sells for the equivalent of 65 cents a gallon in Paris, 60 cents in Lisbon, 77 cents in Rome, and 48 cents in London. The products are of poorer quality than in the United States.

Before the average American car is scrapped, it will have consumed 8,000 gallons of gasoline and run up $588 in gasoline taxes.

Going over the $2 billion mark for the first time, gasoline and other automotive taxes collected in 1952 by the federal government totaled $2,100,066,269.

This is the new muskeg tractor, which will greatly increase the speed with which the muskeg regions of northern Canada can be explored for oil, as announced by Gulf Oil Corporation. The all-track was designed and built by Bombardier Snowmobile, Ltd. of Valcourt, Quebec.

Shell Oil to Participate Again in SCCA Races

Shell Oil Company is planning to take a part in sports car racing again this year. The program looks toward participation in many of the biggest events on the schedule of the Sports Car Club of America, which will involve the company in a program of about the same size as last year.

The company will provide gasoline, motor oil, and a service center equipped with mobile lifts, wheel balancers, ignition system checking machines, battery chargers and other equipment.

Shell has long been interested in sports car racing here and abroad because it enables automotive technicians to study the performance of fuels and lubricants under the gruelling driving conditions.

Spot Announcements Made Available by API

To help local oil men prepare effective radio commercials, the American Petroleum Institute has produced a packet of 16 spot announcements which can be used by fuel oil jobbers, service station dealers, and oil companies.

The suggested announcements can be used for spot or station breaks, or as "lead-in" copy for programs sponsored by oil companies. Leeway is provided for inclusion of each company's local copy.

The packets are being distributed by District Offices of the Oil Industry Information Committee to local radio stations and oil men using radio time. The kit is designed for year-round use by oil men and supplements, radiowise, an advertising mat service for local newspapers announced previously.

It is estimated that by 1960 man will perform only three percent of the physical work in the United States. Animals will do one percent and machines 96 percent. Before 1859, when oil industry started, man did 15 percent, animals 79 percent and machines 6 percent.

Gasoline Sign Honored By Museum of Modern Art

Internationally-known judges of good modern design have honored a familiar gasoline sign. The big yellow plastic shell with red letters that identifies Shell service stations is being displayed by the Museum of Modern Art in New York as "an outstanding example of good legibility combined with aesthetic appeal."

According to a Shell Oil spokesman, Shell Oil manager for this area, the company's symbol-sign was chosen from a wide variety of signs that appear along streets and roads all over the world. "We are tremendously gratified by the honor" he said, because it recognizes the time, effort and large sums of money we have spent improving not only our signs but the over-all appearance of our service stations as well."

Familiar service station identification chosen as example of outstanding design.

Among the more familiar of five other signs chosen by the museum for their artistic merit are the F. W. Woolworth Company store sign and the Columbia Broadcasting System "eye," which is also the network's television trademark. There is also a display of "horrible examples," including a hodge-podge of six different signs on a single metropolitan lamppost that is cited as "low in artistic value, high in confusion."

An actual full-size Shell sign is on exhibit in the museum's garden and a color transparency showing the lighted sign at night is featured in one of the galleries. A museum spokesman pointed out that they stress good lighted signs because "at night they dominate the architecture of our towns and create a new atmosphere."

Oil Booklet Available

The release of a booklet, entitled "OIL FOR TODAY AND – FOR TOMORROW," has been announced by the Interstate Oil Compact Commission, as the most spectacular phase of its educational program of promoting the conservation of vital oil and gas resources.

This booklet, dealing with the origin, production, conservation and importance of oil and gas, satisfies a long felt need for the presentation in condensed form of important aspects of the production and conservation problem in a way that laymen, such as legislators and students, can easily understand.

Lt. Gen. Ernest O. Thompson, chairman of the Texas Railroad Commission, who is recognized internationally for his monumental contributions to the cause of the prevention of waste of oil and gas, explains in this booklet perhaps one of the most important aspects of conservation—assurance of an adequate supply of oil and gas for national security and for freedom. In his words, "Every barrel of oil produced by good conservation methods is an extra barrel for our economy and security."

The booklet is a compilation of chapters written by some of the nation's foremost authorities: General Thompson; George Hazlett, oil and gas attorney; H. H. Kaveler, petroleum engineer and management consultant; Harold B. Fell, independent operator and executive vice-president of the Independent Petroleum Association of America; and officers and members of the staff of the Compact Commission.

Copies of this 84-page, illustrated booklet, in color, are available upon request to the IOCC Headquarters Office, Box 3127, Oklahoma City, Okla., and bulk orders will be filled at approximately cost of publication.

FUTURE MEETINGS of the Industry

MAY, 1954

20-21 National Industrial Conference Board (38th annual meeting), Waldorf-Astoria, New York, N. Y.

20-21 Kentucky Oil & Gas Assn., Lafayette Hotel, Lexington, Ky.

23-28 North Carolina Oil Jobbers Assn. (spring convention), cruise from Norfolk to Bermuda.

24-25 Packaging Institute (petroleum packaging committee), Cleveland, Ohio.

27-28 Western Petroleum Refiners Assn., Broadview Hotel, Wichita, Kan.

31-June 5 American Petroleum Institute (division of production, mid-year committee conference), San Francisco, Calif.

JUNE, 1954

3-4 Pennsylvania Grade Crude Oil Assn., William Penn Hotel, Pittsburgh, Pa.

6-11 Society of Automotive Engineers (summer meeting), The Ambassador and Ritz-Carlton Hotels, Atlantic City, N. J.

9-11 Oil Industry Information Committee, Edgewater Beach Hotel, Chicago, Ill.

13-18 American Society for Testing Materials (annual meeting and exhibits), Sherman Hotel, Chicago, Ill.

17-19 American Petroleum Institute (Division of Production, Eastern District), Greenbrier Hotel, White Sulphur Springs, W. Va.

21-25 American Inst. of Electrical Engineers (combined summer and Pacific general meeting), San Francisco, Calif.

24-25 Western Petroleum Refiners Assn. (regional meeting), Leonard Refineries Auditorium, Alma, Mich.

27-July 1 Petroleum Equipment Suppliers Assn., Manoir Richelieu, Quebec, Canada.

AUGUST, 1954

16-18 Society of Automotive Engineers (national West Coast meeting), Los Angeles, Calif.

SEPTEMBER, 1954

8-10 Oil Industry Information Committee, Conrad Hilton Hotel, Chicago, Ill.

12-14 Empire State Petroleum Assn., Hotel Syracuse, Syracuse, N.Y.

12-16 Society of Automotive Engineers (national tractor meeting), Schroeder Hotel, Milwaukee, Wis.

12-16 American Inst. of Chemical Engineers, Colorado Hotel, Glenwood Springs, Colo.

12-17 American Chemical Society, New York, N. Y.

13-14 Packaging Institute (petroleum packaging committee), Philadelphia, Pa.

15-17 National Petroleum Assn. (52nd annual meeting), Traymore Hotel, Atlantic City, N. J.

16-17 Mid-Continent Oil and Gas Assn. (annual meeting), Roosevelt Hotel, New Orleans, La.

22-23 Ohio Petroleum Marketers Association (fall conference and golf tournament), Hollenden Hotel and Westwood Country Club, Cleveland, Ohio.

23-24 Western Petroleum Refiners Assn. (regional meeting), Henning Hotel, Casper, Wyo.

26-28 Pennsylvania Petroleum Assn., Inc., Pocono Manor Inn, Pocono Manor, Penna.

27-28 Independent Oil Compounders Association (7th annual meeting), Sheraton Hotel, Chicago, Illinois.

OCTOBER, 1954

4-6 Texas Mid-Continent Oil and Gas Assn. (annual meeting), San Antonio, Texas.

4-9 Society of Automotive Engineers (national aeronautic meeting), aircraft engineering display, and aircraft production forum, Hotel Statler, Los Angeles, Calif.

10-12 National Assn. of Oil Equipment Jobbers (4th annual meeting), Congress Hotel, Chicago, Ill.

Week of Oct. 18 Society of Automotive Engineers (national transportation meeting), Boston, Mass.

20-21 Nebraska Petroleum Marketers Assn. (annual convention), Paxton Hotel, Omaha, Neb.

21-22 Western Petroleum Refiners Assn. (Garrett Hotel), El Dorado, Ark.

23-25 National Association of Oil Equipment Jobbers (annual meeting), Hotel President, Kansas City, Mo.

25-26 Independent Petroleum Assn. of America (annual meeting), Tulsa, Okla.

25-26 Independent Petroleum Assn. of America (annual meeting), Shamrock Hotel, Houston, Texas.

25-27 NLGI ANNUAL MEETING, MARK HOPKINS HOTEL, SAN FRANCISCO, CALIF.

25-29 American Institute of Electrical Engineers (fall general meeting), Chicago, Ill.

26-27 Society of Automotive Engineers, national diesel engine meeting, Hotel Statler, Cleveland, Ohio.

NOVEMBER, 1954

4-5 Society of Automotive Engineers (national fuels and lubricants meeting), Mayo Hotel, Tulsa, Okla.

8-11 American Petroleum Institute (34th annual meeting), Conrad Hilton Hotel and Palmer House, Chicago, Ill.

28 to Dec. 3 American Socy. of Mechanical Engineers, Statler Hotel, New York, N. Y.

29-30 Packaging Institute (Petroleum Packaging Committee), New York, N. Y.

DECEMBER, 1954

2-7 National Exposition of Power and Mechanical Engineering, Commercial Museum, Philadelphia, Penna.

8-10 Oil Industry Information Committee, Waldorf-Astoria, New York, N. Y.

12-15 American Inst. of Chemical Engineers (annual meeting), Statler Hotel, New York, N. Y.

JANUARY, 1955

10-14 Society of Automotive Engineers (golden anniversary annual meeting), The Sheraton-Cadillac Hotel and Hotel Statler, Detroit, Michigan

Wheels and Stones That Turn

Since man first began to develop and use his reasoning processes he has recognized the fact that there existed a thing which we call friction.

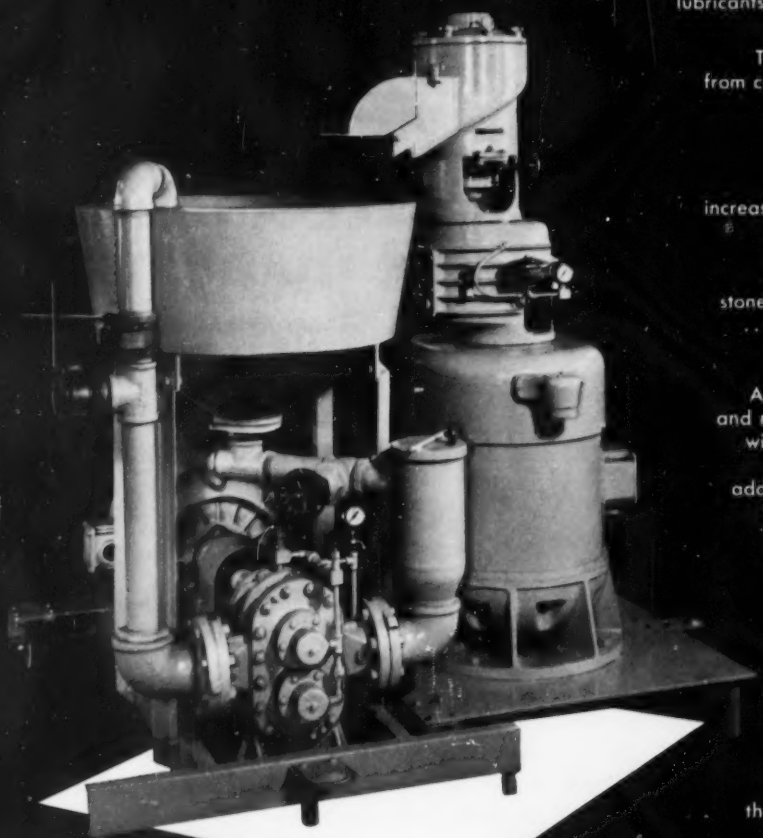
And the development of the wheel brought about the problem of lubrication. Historically, lubricants are believed to have been in use over 7000 years.

But the wheels turned faster and faster. Transition was made from slow speed to high speed, from crudity to precision, from man-power to mechanical power, and from spasmodic hand lubrication to automatic application of an ever-increasing number of highly specialized greases.

With these developments came ever-increasing demands for higher quality, better uniformity, and greater homogeneity. Morehouse engineers . . . looking for a solution . . . followed the same development pattern. They developed high-speed stone milling to a high degree of perfection. The stones . . . operating in a horizontal plane in the Morehouse Mills . . . went faster and faster, reaching their present high-production speed of 5400 R.P.M. And, turning back to friction to make it the servant and not the master, Morehouse engineers collaborated with The Carborundum Company to develop specific stones for specific products. Finally, Morehouse added accurate adjustment of stone separation . . . in 1/1000's of an inch up to ⅛ inch . . . to obtain the exact degree of homogenization, emulsification, disintegration, dispersion, blending, or grinding desired for each particular lubrication product.

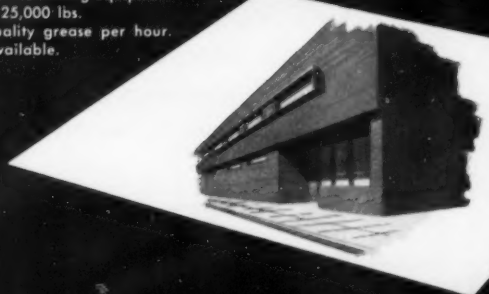
A closely allied problem, deaeration, was met head on and solved. Today you benefit from the combined Morehouse milling and deaeration equipment. It is portable and easy to move about. It gives you the answer to many of your today's problems . . . higher quality, better uniformity, greater homogeneity.

Thus the turning wheels have evolved the turning stones . . . the stones in Morehouse Mills. May we help you?



This large Morehouse grease milling and deaerating equipment produces up to 25,000 lbs. of high quality grease per hour. Smaller units available.

LOOK FOR THIS PENNANT ON GREASE PROCESSING EQUIPMENT . . . IT IS YOUR INDICATION OF LEADERSHIP



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. . . for sturdy construction . . . for trim appearance . . . for product protection

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1. **J&L Drums and Pails are made from high quality J&L Steel Sheet.**
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You can obtain J&L Steel Drums and Pails through plants located in leading industrial centers. You'll find J&L service fast and efficient.

The J&L line includes all types of Closures and Finishes. Bright, colorful decorations may be reproduced to your specifications. Heavy-duty ICC Drums. Light-gauge Drums. 55, 30 and 15 gal. capacity and 100-lb. Grease Drums. Lightweight Drums for Chemical and Powdered Materials. 1-10 gal. capacity Steel Pails for Foods, Chemicals, Oils.

Jones & Laughlin

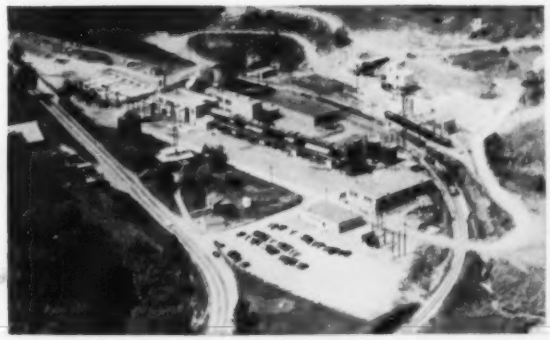
STEEL CORPORATION — *Pittsburgh*

CONTAINER DIVISION

405 Lexington Avenue, New York 17, New York

FOOTE'S *Integrated* Lithium Operation

production



SUNBRIGHT, VA.

. . . world's largest plant for the production of lithium chemicals.

research

BERWYN, PA.

. . . a continuing program to develop new and improved uses for lithium chemicals for the benefit of all industry.

raw material

KINGS MOUNTAIN, N. C.

. . . an assured supply of lithium ore from the largest known deposits of spodumene in the Western Hemisphere.

FOOTE maintains Leadership in Lithium

FOOTE MINERAL COMPANY

402 Eighteen W. Chelten Building, Philadelphia 44, Pa.
RESEARCH LABORATORIES: Berwyn, Pa.
PLANTS: Exton, Pa.; Kings Mountain, N.C.; Sunbright, Va.

It Won't Take Long to Amortize

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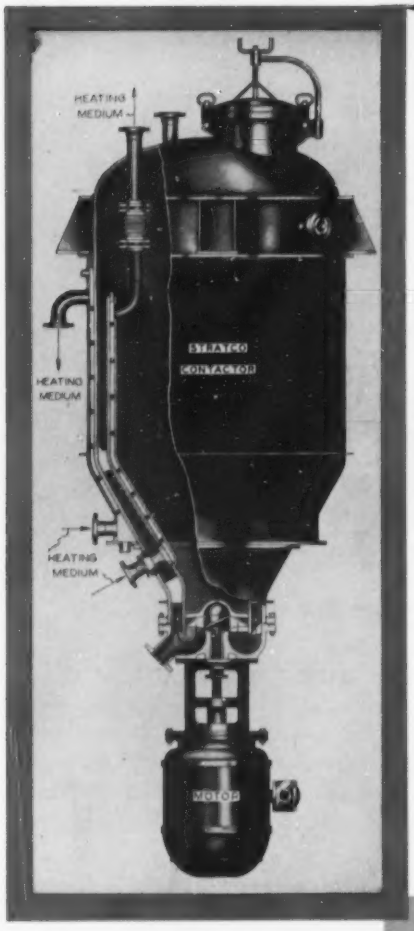
Reg. U. S. Pat. Off.



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Improve product uniformity

You can write off the initial investment against all these advantages . . . and have a better plant left over.

Why not investigate?

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